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Morphological characterization of indigenous sheep population in their production system for developing suitable selection criteria in central zone of Tigray, Northern Ethiopia

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The aim of this study was to characterize the phenotype of the indigenous sheep population in central zone of Tigray. A total of 450 mature sheep were sampled randomly for collect qualitative data. Based on dentition adult sheep were classified into four age categories (from one pair of permanent incisor to four pair of permanent incisor). Coat colour, tail type, ear orientation and presence of wattle were significant ($p<0.05$) between districts studied. Among the three districts only within Tanqua-Abergelle district attributes of coat colour type, tail form, horn and wattle were found to be significant ($p<0.05$). Majority of the sheep population in Tanqua-Abergelle district had a dark red coat colour type (50.2%), while in Kola-Tembien and Adwa districts sheep were dominated by gray coat colour type (30.1 and 40.8%) respectively. Most of the sampled sheep population across the three districts were short fat tailed followed by short thin and rumped fat tail type. Multiple correspondence analysis indicated that the sampled sheep population in the study districts were clustered into two groups based on their unique characteristics; Kola-Tembien and Adwa sheep together as one group while Tanqua-Abergelle district sheep as the other group, based on their unique characters. Based on the present result on characterization of sheep in the study area one may develop selection criteria and productivity schemes of the local sheep.

Key words: Adwa, Kola-Tembien, Tanqua-Abergelle, qualitative traits, suitable selection criteria.

INTRODUCTION

Ethiopia is endowed with 29.33 million sheep head (CSA, 2015) with diversified genetic pools adapted to a wide range of agro-ecologies. Environmental pressure also maintains a wide range of genotypes, each adapted to a specific set of circumstances (Getachew et al., 2010). At least 9 sheep breeds and 14 traditional sheep populations are found in Ethiopia (Gizaw et al., 2007). Although the production system and marketing are

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almost traditional (Legesse et al., 2008), sheep contribute substantial amounts to income, food (meat and milk), and non-food products like manure, skins and wool. They also serve as a means of risk mitigation during crop failures, property security, financial saving and investment in addition to many other socioeconomic and cultural functions (Tibbo, 2006).

Sheep productivity in Ethiopia is constrained by lack of technical capacity, scarce feed, diseases, insufficient infrastructure and market information resulting in varying sheep distribution and marketing across space and time (Samson and Frehiwot, 2014) and inadequate utilization of the indigenous sheep genetic resources. In spite of the several constraints, sheep in Ethiopia have been able to contribute significantly to the income of the small holder farmers/ pastoralists and also help in poverty alleviation schemes (Kosgey and Okeyo, 2007).

Genetic variation within a population provides information on the potential response of a population to adapt to the environment and selective genetic improvement (Abegaz et al., 2011). Therefore, all the breed improvement programs are based on effective utilization of genetic variation among the animals. Traits such as body weights and rate of gain that can be easily measured are among traits having the most economic importance. Improvement in live weight through indirect selection on linear size traits is possible both under nucleus and village-based breeding programs (Gizaw et al., 2008). Identification and defining the production system of any breed is the bases for breed improvement strategies and scheme.

Genetic improvement of the local livestock through appropriate techniques or selection and breeding programme is the need of the day especially under production constraints (Yakubu, 2010). The usefulness of system and breed characterization of the indigenous livestock in general and sheep in particular is unquestionable. Hence characterization, inventory and monitoring of animal genetic resources (AnGR) are essential to their sustainable management and facilitate effective planning of how and where they can best be used and developed (FAO, 2015).

The study areas are potential in sheep production, little works was done to characterize or to improve the indigenous sheep population of Tanqua-Abergelle, Kola-Tembien and Adwa districts by Gizaw (2008) under the name of Sokota sheep breed providing some information on some physical body measurements and characteristics.

Therefore this research was initiated to characterized phenotype of the existing sheep population in their production system. This will serve to develop genotypic characterization and develop improvement strategies and productivity schemes of the local sheep. Since genetic resources and production systems are not static and thus routine inventories and thus on-going monitoring is needed (Sölkner et al., 1998).

The objective of this study was to characterize sheep in Central Zone of Tigray in their production system based on their qualitative traits so that suitable selection criteria for sheep may be suggested.

MATERIALS AND METHODS

Description of study area

The study was conducted in three districts of central zone of Tigray, Ethiopia (Tanqua Abergell, Kola-Tembien and Adwa) (Figure 1).

The central zone of Tigray covers about 9741 km^2 with a total population of 1,132,229. The central zone is divided into nine districts and three major marketing towns-Axum, Adwa and Abyi Adi. The zone consists of about 406,018 sheep (CSA, 2015). The elevation of the area ranges from 1332 to 2921 m a.s.l. Annual rainfall is vary within a range of 466 to 758 mm. Temperature ranges from 14 to 22°C. Most of the lands are cultivated for crop purpose with some patchy grazing bottomlands and degraded hilly sites. Major soil types in the study areas include Eutric and Chromic Cambisols, Eutric and Lithic Leptosols, Eutric Cambisols and Lithic Leptosols (CSA, 2015).

Site selection and sampling technique

From among the nine districts of central zone of Tigray, three districts were selected using multi- stage purposive sampling techniques, based on the sheep population density and road accessibility. From each selected districts two rural kebeles (Felege-Hiwet and Gera from Tanqua Abergelle district, Werka-Emba and Debre-Tsehay from Kola-Tembien and Debre-Gent and Endamaryam-Shewito from Adwa) were selected purposively based on the sheep flock density and accessibility for transportation. Accordingly, a total of 450 healthy adult sheep (135 male and 315 non pregnant females in the proportion of 30 male: 70 female) were selected randomly (209 from Tanqua-Abergelle, 143, from Kola-Tembien and 98 from Adwa district). The sheep were identified by sex, districts and four age groups (1PPI-1 pair of permanent incisor), 2PPI (2pair of permanent incisor), 3PPI (3 pair of permanent incisor) and 4PPI (4 pair of permanent incisors) for the base line data collection (characterization) as per the method of Wilson and Durkin (1984).

Data type and methods data collection

Data on morphological variables on the selected animals for qualitative traits (morphological) were recorded as the following.

Qualitative traits (morphological variables)

The standard breed descriptor list for sheep developed by FAO (2012) was followed in selecting morphological variables. Data for qualitative traits like: Coat color pattern, coat color type, hair type, head profile, ears orientation, wattle, presence or absences of horn, ruff and tail type and shape were recorded using individual interviews, group discussion and observation on the animal.

Data management and analysis

Qualitative traits

Qualitative data from individual observation were analyzed

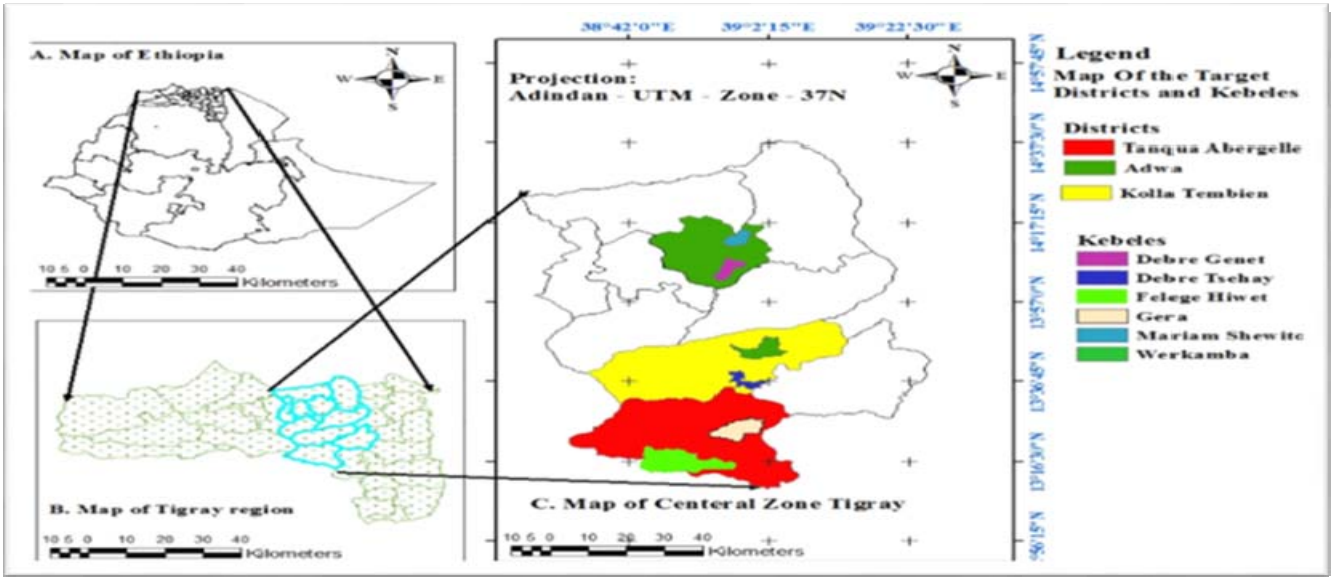

Figure 1. Map of the study area.

separately for male and female sheep using frequency procedure of Statistical Analysis System SAS version release 9.2 (2008) within population. Chi-square was employed when required to test the independence of categories or to assess the statistical significance ($p \leq 0.05$) within population. Chi-square was also calculated across/between population to test the existence of significance differences between populations. Multiple correspondence analysis was carried out to evaluate the typical features or associations of each district sampled sheep population morphologically.

RESULT AND DISCUSSION

Morphological traits

The number and percentage of each level of the 13 qualitative traits recorded in male and female for each districts are presented in Table 1. In Tanqua-Abergelle district the dominant coat color type were dark red, white and black with the proportions of 50.7, 12.4 and 11.5%, respectively. Grey mixture local name (‘*Agua*’), black dominant, white dominant and dark red dominant were also observed with the proportions of 10.5, 9.1, 4.8 and 1.0%, respectively. This finding is in agreement with that of Tajebe et al. (2011) who reported the dominated coat color type of Abergelle sheep breed was dark red followed by white and black, whereas in Kola-Tembien and Adwa sampled sheep population grey (‘*Agua*’), dark red and black coat color were observed dominantly with the proportion of 30.1, 25.2, 14.0% and 40.8, 24.4 and 9.2%, respectively. Nearly 54.5, 27.8 and 18.2% of the sampled sheep in Tanqua-Abergelle had plain coat color pattern, spotted pattern and patchy pattern, respectively.

Similarly the proportion of plain coat color pattern, spotted pattern and patchy pattern for the sampled sheep of Kola-Tembien and Adwa districts were 59.4, 25.2, 15.4% and 67.3, 22.4 and 10.2%, respectively. The present finding is in line with the finding of Melesse et al. (2013) reported that coat color pattern of Kembata Tembaro-Hadiya, zone of southern Ethiopia of sampled sheep were dominantly by plain coat colour pattern with 75.5%.

Almost all the male and female sampled sheep population across the study districts were short fat tailed followed by short thin and medium tail fat type with curved tip, strait tip and docked tail with the proportion of 91.5, 7.2% 1, 81.3, 11.5 and 7.2% for Tanqua-Abergelle, 71.3, 12.6, 16.1, 80.4, 11.9 and 7.7% for Kola-Tembien and 63.2, 29.6 8.2, 77.6, 15.3 and 9.2% for Adwa sheep. Majority of the sampled sheep population in all the study districts had smooth hair type and concave head profile with the percentage of 63.2 and 52.2 for Tanqua-Abergelle, 60.1 and 55.2 for Kola-Tembien and 58.2 and 56.1 for Adwa sheep. This finding is comparable with the previous work done Hayelom et al. (2014) who reported that majority sampled sheep of Degua-Tembien had smooth hair type and concave face profile with proportion of 75 and 64%, respectively. In Tanqua-Abergelle district most of the sampled sheep population had rudimentary ear, 61.7, 20.6% erect, 12.4% semi pendulous, 4.8% pendulous and 0.5% horizontal, while in Kola-Tembien and Adwa the sampled sheep had dominantly semi pendulous and erect ear, 30.8, 23.8% and 38.8%, 17.3%, respectively. The remaining small proportion of sampled sheep had rudimentary, pendulous and carried horizontally in their order were 17.5, 18.2, 9.8% and 12.2, 15.3 and 16.3%, respectively.

Most of male and female sampled sheep populations across the study districts were polled or hornless 82.8%

Table 1. Description of qualitative traits of sheep populations in the study districts.

Traits	Attributes	Tanqua-Abergelle						Kolla Tembien						Adwa					
		M		F		Total		M		F		T		M		F		T	
		N	%	N	%	N	%	N	N%	N	%	N	%	N	N%	N	%	N	%
Coat colour type	Black	11	5.3	13	6.2	24	11.5	7	5.0	13	9.1	20	14.0	2	2.0	7	7.1	9	9.2
	White	6	2.9	20	9.6	26	12.4	8	5.6	10	7.0	18	12.6	2	2.0	9	9.2	11	11.2
	Dark red	38	18.2	68	33.0	106	50.7	16	11.2	20	14.0	36	25.2	11	11.2	9	9.2	20	20.4
	Gray	6	2.9	16	7.7	22	10.5	8	5.6	35	24.5	43	30.1	5	5.1	35	35.7	40	40.8
	Black dominant	5	2.4	14	6.7	19	9.1	3	2.1	10	7.0	13	9.1	1	1.0	12	12.2	13	13.3
	White dominant	3	1.5	7	3.3	10	4.8	2	1.4	5	3.5	7	5.0	-	-	4	4.1	4	4.1
	Dark red dominant	-	-	2	1.0	2	1.0	1	0.7	5	3.5	6	4.2	-	-	1	1.0	1	1.0
	χ2 -w/n p		15.4^{ns}						5.1^{ns}						12.3^{ns}				
	χ2 -b/n p									35.9^{ns}									
Coat colour pattern	Plain	46	22.0	68	32.5	114	54.5	25	17.5	60	42.0	85	59.4	16	16.3	50	51.0	66	67.3
	Patchy	9	4.3	29	13.9	34	18.2	5	3.5	17	11.9	22	15.4	3	3.1	7	7.1	10	10.2
	Spotted	14	6.7	44	21.1	53	27.8	15	10.5	21	14.7	36	25.2	2	2.0	20	20.4	22	22.4
	χ2 - w/np		4.23^{ns}							2.49^{ns}						3.4^{ns}			
	χ2 - b/np								3.2^{ns}										
Hair type	Smooth	38	18.2	94	45.0	123	63.2	27	18.9	59	41.3	86	60.1	12	12.2	45	45.9	57	58.2
	Course	31	14.8	47	22.5	78	37.3	18	12.6	39	27.3	57	39.9	9	9.2	32	32.7	41	41.8
	χ2 -w/np.			1.7^{ns}						0.01^{ns}						0.00^{ns}			
	χ2 -b/np.								0.35^{ns}										
Tail type	Short fat	67	29.2	125	59.8	192	91.9	34	23.8	68	47.6	102	71.3	16	16.3	45	45.9	61	62.2
	medium fat	1	0.5	1	0.5	2	1.0	6	4.2	17	11.9	23	16.1	3	3.1	26	26.5	29	29.6
	Short thin	1	0.5	14	6.7	15	7.2	5	3.5	13	9.1	18	12.6	2	2.0	6	2.0	8	8.2
	χ2 b/np			5.7^{ns}						0.27^{ns}						2.57^{ns}			
	χ2 w/np								57.1**										
Tail form	Curved tip	61	30.4	109	52.2	170	81.3	36	25.2	79	55.2	115	80.4	15	15.3	61	62.2	76	77.6
	Strait tip	2	1.0	22	10.5	24	11.5	5	3.5	12	8.4	17	11.9	2	2.0	13	13.3	15	15.3
	Docked	6	2.9	9	4.3	15	7.2	4	2.8	7	4.9	11	7.7	4	4.1	5	5.1	9	9.2
	χ2 w/n pon			8.2 ^{ns}						0.15^{ns}						4.2^{ns}			
	χ2 b/n pon.								0.32^{ns}										
Head profile	Strait	24	11.5	42	20.1	66	31.6	11	7.7	29	20.3	40	28.0	4	4.1	20	36.4	24	24.5
	Convex	12	5.7	22	10.5	34	16.3	6	6.7	18	12.6	21	16.8	3	3.1	16	16.3	19	19.4
	Concave	33	15.8	76	36.4	109	52.2	28	19.6	51	35.7	79	55.2	14	14.3	41	41.8	55	56.1
	χ2 w/n pon			2.5^{ns}						0.91^{ns}						2.3^{ns}			

Table 1. Contd.

	χ2 b/n pon.									1.7^{ns}									
Horn	Present	32	15.3	4	1.9	36	17.2	17	11.9	3	2.1	20	14.0	10	10.2	2	2.0	12	
	Absent	37	17.7	136	65.1	173	82.8	28	19.6	95	66.4	123	86.0	11	11.2	75	76.5	97	
		57.9^{ns}					29.95					35.6^{ns}							
	Lateral	13	36.1	2	5.6	15	41.7	6	30.0	1	5	7	35.0	3	23.1	2	15.4	5	34.5
Horn orientation	Backward	19	52.8	2	5.6	21	58.3	11	55.0	2	10	13	65.0	7	53.9	1	7.7	8	61.5
	χ2 w/n pon			0.13^{ns}						0.0004^{ns}						0.98^{ns}			
	χ2 b/n pon.									0.24^{ns}									
Horn shape	Strait	10	27.8	-	-	10	27.8	4	20.0	-	-	4	20.0	3	23.1	1	7.7	4	30.8
	Curved	13	36.1	2	5.6	15	41.7	7	35.0	2	10.0	9	45.0	5	38.5	1	7.7	6	46.2
	Spiral	8	22.2	2	5.6	10	27.8	6	30.0	1	5.0	7	35.0	2	13.4	1	7.7	3	23.1
	Corkscrew	1	2.8	-	-	1	2.8	-	-	-	-	-	-	-	-	-	-	-	-
	χ2 - w/np.	2.3^{ns}																	
	χ2 -b/np.									7.9^{ns}									
Ear orientation	rudimentary	40	19.1	89	42.6	129	61.7	7	4.9	18	12.6	25	17.5	5	5.1	7	7.1	12	12.2
	Erect	13	6.2	30	14.4	43	20.6	10	7.0	24	16.8	34	23.8	3	3.1	14	14.3	17	17.3
	Semi-pendulous	10	4.8	16	7.7	26	12.4	16	11.2	28	19.6	44	30.8	8	8.2	30	30.6	38	38.8
	pendulous	5	2.4	5	2.4	10	4.8	9	6.3	17	11.9	26	18.2	-	-	15	15.3	15	15.3
	Carried horizontally	1	0.5	-	-	1	0.5	3	2.1	11	7.7	14	9.8	5	5.1	11	11.2	16	16.3
	χ2 -w/np.	3.6^{ns}								2.0^{ns}						9.2^{ns}			
	χ2 -b/np.									134.9**									
Ruff	Present	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-
	Absent	69	33	140	67.0	209	100	45	31.5	98	68.5	143	100	21	21.4	77	78.6	98	100
Wattle	Present	16	7.7	4	1.9	20	9.6	0	0	7	4.9	7	4.9	-	-	1	1.0	1	1.0
	Absent	53	25.4	136	65.1	181	90.4	45	31.5	91	63.6	133	95.1	21	21.4	76	77.6	108	99.0
	χ2 -w/np.			20.55**						3.5^{ns}						0.24^{ns}			
	χ2 -b/np.									10.4**									

N = Number of observations; % = percentage of observations; M = male; F = female; χ2 -w/np = chi-square within population; χ2 -b/np = chi-square between population; ** = significant at ($p<0.05$); ns = non-significant.

in Tanqua-Abergelle, 86% in Kola-Tembien and 87.8% in Adwa districts. The remaining small proportion of both sexes had horn 17.2% in Tanqua-Abergelle, 14% in Kola-Tembien and 12.2% in Adwa district. The current result is in consistence with the previous work done Hayelom et al. (2014) in Tanqua-Abergelle, 86% in Kola-Tembien and 87.8% in Adwa districts. The remaining small proportion of both sexes had horn

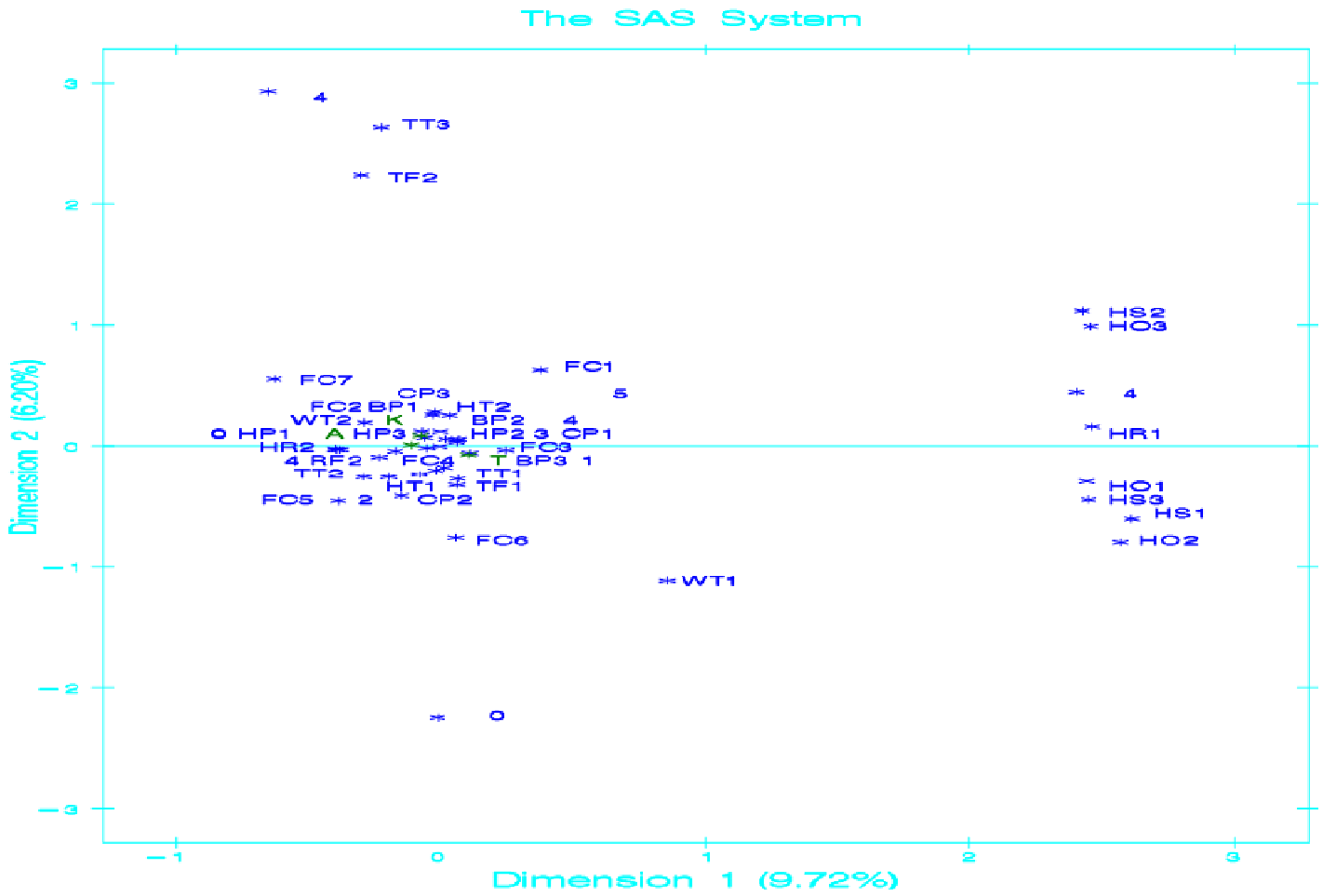

Figure 2. Association (relation) among different categories of qualitative traits using multiple correspondence analysis techniques.

17.2% in Tanqua-Abergelle, 14% in Kola-Tembien and 12.2% in Adwa district. The current result is in consistence with the previous work done Hayelom et al. (2014) reported that majority 80% of the sampled sheep of Tigray highland were polled but, different from the previous work done (Getachew, 2008; Edea, 2008) reported that both sexes of Afar and Horro sheep were polled or hornless.

In all the study districts all the sample sheep population 100% had no ruff and about 7.7% male and 1.9% female sampled sheep in Tanqua-Abergelle had wattle, whereas in Kola-Tembien and Adwa districts the male sampled sheep had no wattle rather female 4.9 and 1%, respectively had wattles. The present finding is in line with that of Mohamed et al. (2015) and Getachew (2008) who reported male sampled sheep in Habru and Afar sheep had no wattles.

Chi-square test for assumption of equal proportion of categorical variables in all the study districts (Tanqua-Abergelle, Kola-Tembien and Adwa) sample sheep population indicated that among the variables considered in this study coat colour type, tail type, ear orientation and wattle presence were significant ($p<0.05$) between districts. Among the three districts only within Tanqua-Abergelle district attributes of coat colour type, tail form, horn and wattle were found to be significant ($p<0.05$). The uniformity in coat colour type in Kola-Tembien and Adwa sheep might be due to similar coat colour preference and selection practice.

Multiple correspondence

Multiple correspondence analyses was carried out to evaluate the typical features of each district sampled sheep population morphologically. Figure 2, shows a dimensional graph representing the association among the categories of the analyzed qualitative traits. The association is based on the point found in approximately the same direction from the origin in approximately in the same region of the space. From the figure shown that 15.92% of the total morphological variation in sheep population is explained by the first two dimensions 9.72% by the first and 6.20% by the second dimensions. From

Figure 3. Morphological views of the sampled sheep in the study districts.

Table 2. Key abbreviation.

Variable	Description
Districts	T= Tanqua-Abergelle, K= Kola-Tembien, A= Adwa
Coat colour type	C1=Black, C2=Gray, C3=Dark red, C4=Dark red dominant, C5= Black Dominant, C6= White dominant, C7= White
Coat colour pattern	CP1=Plain, CP2= Patchy, CP3= Spotted
Hair type	HT1= Short smooth, HT2= Course
Tail type	TT1=Short fat, TT2=Short thin, TT3= Medium fat tail
Tail form	TF1=Curved tip, TF2=Strait tip, TF3=Docked
Head profile	HP1=Strait, HP2=Convex, HP3=Concave
Horn	HR1=Present, HR2=Absent
Horn orientation	HO1=Upward, HO2=Lateral, HO3=Backward
Horn shape	HS1= Strait, HS2=Curved, HS3=Spiral
Back profile	BP1=Strait, BP2=Slops towards rump, BP3=Slops down from rump
Ear orientation	EO1=Rudimentary, EO2=Erect, EO3=Semi-pendulous, EO4= Pendulous, EO5=Carried horizontally
Ruff	RF1= Present, RF2=Absent
Wattle	WT1= Present, WT2= Absent

the identified dimensions the sample sheep population in Kola-Tembien and Adwa districts clustered together with characters grey and white coat colour type, spotted coat color pattern, concave head profile, strait back profile, medium tail fat with strait tip and with no wattle and ruffs, whereas the sampled sheep in Tanqua-Abergelle district the traits clustered together closely associated with dark red coat colour type, short fat tail type with curved tip, upward and later horn orientation with strait and spiral horn shape and slops down from rump back profile as it indicate in (Figure 3).

Conclusions

Sheep population across the three districts were short fat tailed followed by short thin and rumped fat tail type. Coat colour, tail type, ear orientation and presence of wattle were significantly different ($p<0.05$) between districts studied. Multiple correspondence analysis indicated that the sampled sheep population in the study districts were clustered into two groups based on their unique morphological characteristics; Kola-Tembien and Adwa sheep together as one group and Tanqua-Abergelle district sheep as the other group. Among the three districts only within Tanqua-Abergelle district, attributes of coat colour type, tail form, horn and wattle were found to be significant ($p<0.05$).

CONFLICTS OF INTERESTS

The authors have not declared any conflict of interests

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